Sets and Relations

Question1

If $\mathrm{A} = \{\mathrm{x} : \mathrm{x}$ **is an integer and** $\mathrm{x}^2 - 9 = 0\}$

$B = \{x : x$ **is a natural number and** $2 \leq x < 5\}$

$\mathrm{C} = \{\mathrm{x} : \mathrm{x}$ **is a prime number** $\leq 4\}$

Then $(B - C) \cup A$ **is,**

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Options:

A. $\{-3, 3, 4\}$

B. $\{2, 3, 4\}$

C. $\{3, 4, 5\}$

D. $\{2, 3, 5\}$

Answer: A

Solution:

$\mathrm{A} = \{\mathrm{x} : \mathrm{x} \text{ is an integer and } \mathrm{x}^2 - 9 = 0\}$
$\mathrm{x}^2 = 9 \Rightarrow \mathrm{x} = \pm 3 = \{-3, 3\}$
$\mathrm{B} = \{\mathrm{x} : \mathrm{x} \text{ is a natural number and } 2 \leq \mathrm{x} < 5\}$
$= \{2, 3, 4\}$
$\mathrm{C} = \{\mathrm{x} : \mathrm{x} \text{ is a prime number } \leq 4\}$
$= \{2, 3\}$
$(\mathrm{B} - \mathrm{C}) \cup \mathrm{A} = \{4\} \cup \{-3, 3\} = \{-3, 3, 4\}$

Question2

A **and** B **are two sets having 3 and 6 elements respectively. Consider the following statements.**

Statement (I): Minimum number of elements in AUB is 3

Statement (II): Maximum number of elements in AB is 3 Which of the following is correct?

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Options:

A. Statement (I) is true, statement (II) is false

B. Statement (1) is false, statement (II) is true

C. Both statements (1) and (II) are true

D. Both statements (I) and (II) are false

Answer: B

Solution:

$$|A| = 3$$
$$|B| = 6$$
$$|A \cup B| = |A| + |B| - |A \cap B|$$
$$\min |A \cup B| = |A| + |B| - \max |A \cap B|$$
$$= 3 + 6 - 3 = 6$$
$$|A \cap B| = |A| + |B| - |A \cup B|$$
$$\max |A \cap B| = |A| + |B| - \min |A \cup B|$$
$$= 3 + 6 - 6 = 3$$

Question3

Let $A = \{a, b, c\}$, then the number of equivalence relations on A containing (b, c) is

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Options:

A. 1

B. 3

C. 2

D. 4

Answer: C

Solution:

To determine the number of equivalence relations on the set $A = \{a, b, c\}$ that include the pair (b, c), we must ensure the relations satisfy the reflexivity, symmetry, and transitivity properties of equivalence relations.

Given:

Reflexivity requires that every element is related to itself: (a, a), (b, b), and (c, c) must be included.

Symmetry necessitates that if (b, c) is included, then (c, b) must also be included.

Transitivity requires that for the inclusion of (b, c), the set must also consider the relationships between (a, b), (b, a), (a, c), and (c, a).

There are two potential equivalence relations:

Minimal relation involving (b, c):

$\{(a, a), (b, b), (c, c), (b, c), (c, b)\}$

Full equivalence connecting all elements:

$\{(a, a), (b, b), (c, c), (a, b), (b, a), (a, c), (c, a), (b, c), (c, b)\}$

Thus, there are 2 equivalence relations on A containing (b, c).

Question4

Consider the following statements :

Statement(I) : The set of all solutions of the linear inequalities $3\text{x} + 8 < 17$ and $2\text{x} + 8 \geq 12$ are $\text{x} < 3$ and $x \geq 2$ respectively.

Statement(II) : The common set of solutions of linear inequalities $3x + 8 < 17$ and $2x + 8 \geq 12$ is $(2, 3)$ Which of the following is true?

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Options:

A. Statement (I) is true but statement (II) is false

B. Statement (I) is false but statement (II) is true

C. Both the statements are true

D. Both the statements are false

Answer: A

Solution:

$3x + 8 < 17 \Rightarrow 3x < 9 \Rightarrow x < 3$
$2x + 8 \geq 12 \Rightarrow 2x \geq 4 \Rightarrow x \geq 2$

Statement I is correct.

The common set of solution $\Rightarrow \{2\}$

$\rightarrow$ Statement II is false

Question5

Two finite sets have m and n elements respectively. The total number of subsets of the first set is 56 more than the total number of subsets of the second set. The values of m and n, respectively are

KCET 2024

Options:

A. $7, 6$

B. $5, 1$

C. $6, 3$

D. $8, 7$

Answer: C

Solution:

Let set A have m elements and set B have n elements

Now,

$2^m - 2^n = 56$

$\Rightarrow \quad 2^n\left(2^{m-n} - 1\right) = 8 \times 7$

$\Rightarrow \quad 2^n\left(2^{m-n} - 1\right) = 2^3 \times 7$

On comparing both sides, we get

$2^n = 2^3$ or $2^{m-n} - 1 = 7$

Now, $n = 3 \quad$ .... (i)

So, $\quad 2^{m-n} - 1 = 7$

$\Rightarrow \quad 2^{m-n} = 8$

$\Rightarrow \quad m - n = 3 \quad$ .... (ii)

From Eqs. (i) and (ii), we get

$m = 6$ and $n = 3$

Question6

Let $A = \{2, 3, 4, 5, \ldots, 16, 17, 18\}$. Let R be the relation on the set A of ordered pairs of positive integers defined by $(a, b)R(c, d)$ if and only if $ad = bc$ for all

$(a, b), (c, d)$ in $A \times A$. Then, the number of ordered pairs of the equivalence class of $(3, 2)$ is

KCET 2024

Options:

A. 4

B. 5

C. 6

D. 7

Answer: C

Solution:

Let $(3, 2) R(x, y)$

$\Rightarrow \quad 3y = 2x$

This is possible in the cases

$x = 3, y = 2$
$x = 6, y = 4$
$x = 9, y = 6$
$x = 12, y = 8$
$x = 15, y = 10$
$x = 18, y = 12$
Hence, total pairs are 6.

Question7

Which of the following is an empty set?

KCET 2023

Options:

A. $\{x : x^2 + 1 = 0, x \in R\}$

B. $\{x : x^2 - 9 = 0, x \in R\}$

C. $\{x : x^2 = x + 2, x \in R\}$

D. $\{x : x^2 - 1 = 0, x \in R\}$

Answer: A

Solution:

Here, $x^2 + 1 = 0$

$$\Rightarrow \quad x^2 = -1$$
$$\Rightarrow \quad \dot{x} = \pm i$$

It x is an imaginary number.

Hence, $\{x : x \text{ is a real number and } x^2 + 1 = 0\}$ is an empty set

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Question8

Let the relation R be defined in N by aRb, if $3a + 2b = 27$, then R is

KCET 2023

Options:

A. $\left\{\left(0, \frac{27}{2}\right), (1, 12), (3, 9), (5, 6), (7, 3)\right\}$

B. $\{(1, 12), (3, 9), (5, 6), (7, 3), (9, 0)\}$

C. $\{(2, 1), (9, 3), (6, 5), (3, 7)\}$

D. $\{(1, 12), (3, 9), (5, 6), (7, 3)\}$

Answer: D

Solution:

Given that $3a + 2b = 27$

$$\Rightarrow \quad 2b = 27 - 3a$$
$$\Rightarrow \quad b = \frac{27 - 3a}{2}$$

For $a = 1, b = 12$

$a = 3, b = 9$
$a = 5, b = 6$
$a = 7, b = 3$
$R = \{(1, 12), (3, 9), (5, 6), (7, 3)\}$

Question9

Suppose that the number of elements in set A is p, the number of elements in set B is q and the number of elements in $A \times B$ is 7, then $p^2 + q^2 =$

KCET 2022

Options:

A. 50

B. 51

C. 42

D. 49

Answer: A

Solution:

Given, $n(A) = p, n(B) = q$ anc $(A \times B) = 7$

Since, $n(A \times B) = n(A) \times n(B)$

$\Rightarrow \quad 7 = p \times q \Rightarrow pq = 7$

So, possible values of p and q are 7, 1 respectively.

$\Rightarrow p^2 + q^2 = 7^2 + 1^2 = 49 + 1 = 50$

Question10

Let the relation R is defined in N by aRb, if $3a + 2b = 27$ then R is

KCET 2022

Options:

A. $\{(1, 12)(3, 9)(5, 6)(7, 3)\}$

B. $\left\{\left(0, \frac{27}{2}\right)(1, 12)(3, 9)(5, 6)(7, 3)\right\}$

C. $\{(1, 12)(3, 9)(5, 6)(7, 3)(9, 0)\}$

D. $\{(2, 1)(9, 3)(6, 5)(3, 7)\}$

Answer: A

Solution:

$$3a + 2b = 27$$
$$\Rightarrow \quad b = \frac{27 - 3a}{2}$$
$$a = 1 \Rightarrow b = \frac{27 - 3}{2} = \frac{24}{2} = 12$$
$$a = 3 \Rightarrow b = \frac{27 - 9}{2} = \frac{18}{2} = 9$$
$$a = 5 \Rightarrow b = \frac{27 - 15}{2} = \frac{12}{2} = 6$$
$$a = 7 \Rightarrow b = \frac{27 - 21}{2} = \frac{6}{2} = 3$$

Hence, we can see that the elements of option (a) satisfies the given relation. Hence, option (a) is correct.

Question11

In a certain two 65% families own cell phones, 15000 families own scooter and 15% families own both. Taking into consideration that the families own at least one of the two, the total number of families in the town is

KCET 2021

Options:

A. 20000

B. 30000

C. 40000

D. 50000

Answer: B

Solution:

Let the total number of families be x.

Let $A =$ number of families that own cell phones

$A(A) = \frac{65}{100} \times x$

Let $B =$ number of families that own scooter

$A(B) = 15000$

and $(A \cap B) =$ number of families that own cell phones and scooter both

$n(A \cap B) = \frac{15}{100} \times x$

Here, $n(A \cup B) = x$

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$
$$x = \frac{65x}{100} + 15000 - \frac{15x}{100}$$

$$\Rightarrow \quad 100x = 65x + 1500000 - 15x$$
$$\Rightarrow \quad 100x - 50x = 1500000$$
$$\Rightarrow \quad 50x = 1500000$$
$$\Rightarrow \quad x = 30000$$

Total number of families in the town is 30000.

Question12

If $n(A) = 2$ and total number of possible relations from Set A to set B is 1024, then $n(B)$ is

KCET 2020

Options:

A. 512

B. 20

C. 10

D. 5

Answer: D

Solution:

Given, $n(A) = 2$ let $n(B) = n$

Total number of relations from set A to set B is

$2^{2\pi} = 1024$
$2^{2n} = 2^{10} \Rightarrow 2n = 10 \Rightarrow n = 5$

Question13

If $A = \{1, 2, 3, 4, 5, 6\}$, then the number of subsets of A which contain at least two elements is

KCET 2020

Options:

A. 64

B. 63

C. 57

D. 58

Answer: C

Solution:

Given set $A = \{1, 2, 3, 4, 5, 6\}$

Number of subsets of A which contain at least two elements is ${}^6C_2 + {}^6C_3 + {}^6C_4 + {}^6C_5 + {}^6C_6$

$= 2^6 - {}^6C_0 - {}^6C_1 = 64 - 1 - 6 = 57$

Question14

If a relation R on the set $\{1, 2, 3\}$ be defined by $R = \{(1, 1)\}$, then R is

KCET 2020

Options:

A. Reflexive and symmetric

B. Reflexive and transitive

C. Symmetric and transitive

D. Only symmetric

Answer: C

Solution:

Let

$A = \{1, 2, 3\}$
$R = \{1, 1\}$

$\{2, 2\} \notin R, R$ is not reflexive but R is symmetric and transitive.

Question15

If $A = \{a, b, c\}$, then the number of binary operations on A is

KCET 2020

Options:

A. 3

B. 3^6

C. 3^3

D. 3^9

Answer: D

Solution:

We have,

$A=\{a, b, c\}$

The number of binary operations on A is $3^{3^2}=3^9$

Question16

If $A=\{x \mid x \in N, x \leq 5\}, B=\left\{x \mid x \in Z, x^2-5x+6=0\right\}$, then the number of onto functions from A to B is

KCET 2019

Options:

A. 30

B. 2

C. 32

D. 23

Answer: A

Solution:

Given, $A=\{x \mid x \varepsilon N, x \leq 5\}$

$\Rightarrow \quad A=\{1,2,3,4,5\}$

and $\quad B=\left\{x \mid x \varepsilon Z, x^2-5x+6=0\right\}$

$\Rightarrow \quad B=\{2,3\}$

$\therefore$ Number of onto function from A to B is

$2^5-2=32-2=30$

Question17

On the set of positive rational, a binary operation * is defined by $a * b = \frac{2ab}{5}$. If $2 * x = 3^{-1}$, then $x =$

KCET 2019

Options:

A. $\frac{2}{5}$

B. $\frac{1}{6}$

C. $\frac{125}{48}$

D. $\frac{5}{12}$

Answer: C

Solution:

A binary operation * is defined by $a * b = \frac{2ab}{5}$

Now, $a * e = \frac{2ae}{5} = a \Rightarrow e = \frac{5}{2}$

$\therefore \quad a * a^{-1} = e$

$\Rightarrow \quad \frac{2aa^{-1}}{5} = \frac{5}{2} \Rightarrow a^{-1} = \frac{25}{4a}$

$\therefore \quad 3^{-1} = \frac{25}{4 \times 3} = \frac{25}{12}$ .... (i)

Since, $\quad 2 * x = 3^{-1}$

$\Rightarrow \quad \frac{2 \times 2 \times x}{5} = \frac{25}{12}$ (using (i))

$\Rightarrow \quad x = \frac{125}{48}$

Question18

If U is the universal set with 100 elements; A and B are two set such that $n(A) = 50, n(B) = 60, n(A \cap B) = 20$ then $n\left(A' \cap B'\right) =$

KCET 2019

Options:

A. 90

B. 40

C. 10

D. 20

Answer: C

Solution:

Key Idea, use Identity $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ and find $n(A \cap B)$, after then use $n(A' \cap B') = n((A \cup B)')$

We have, $n(U) = 100, n(A) = 50, n(B) = 60$ and $n(A \cap B) = 20$

$$\begin{aligned} &\text{Now, } n(A \cup B) = n(A) + n(B) - n(A \cap B) \\ &= 50 + 60 - 20 = 90 \\ &\therefore n\left(A' \cap B'\right) = n\left((A \cup B)'\right) = n(u) - n(A \cup B) \\ &= 100 - 90 = 10 \end{aligned}$$

Question19

If A and B are finites sets and $A \subset B$, then

KCET 2017

Options:

A. $n(A \cup B) = n(B)$

B. $n(A \cap B) = \phi$

C. $n(A \cap B) = n(B)$

D. $n(A \cup B) = n(A)$

Answer: A

Solution:

We have, $A \subset B$

$\therefore A \cap B = A \Rightarrow n(A \cap B) = n(A) \qquad \ldots(i)$

Again, we know that

$$\begin{aligned} &n(A \cup B) = n(A) + n(B) - n(A \cap B) \\ \Rightarrow &n(A \cup B) = n(A) + n(B) - n(A) \quad [\text{ from Eq. (i)}] \\ \Rightarrow &n(A \cup B) = n(B) \end{aligned}$$
